Response to ET Docket No. 16-191

TAC Noise Floor Technical Inquiry

Answers to multi-part questions 1 – 4

1: Is there a noise problem? Yes

a: There are two main types of broadband RF noise, power line noise and RFI from electrical equipment. Maintenance of power distribution insulators has deteriorated over the past 40 years, possibly exacerbated as magnesium chloride has replaced salt used for ice and snow mitigation. Many sources of RFI from electric devices, mostly imported from China, do not comply with FCC rules. Charging equipment and power supplies that exceed specified limits often have had proper EMI filtering removed in production, even if the devices initially pass FCC regulations. Additionally, LED traffic signals emit short-range interference to standard AM broadcast signals received by car radios.

b: Amateur radio (ham radio) operators are drastically affected, having been a ham since 1961. Urban noise levels have increased about 6 dB per decade at my Denver home purchased in 1971. Also standard AM reception has been degraded, as have reception of shortwave broadcasts.

c: Much of imported incidental radiators do not comply to radiation limits. A prime example is electronic ballasts for "grow lights" that unfortunately are prevalent in Colorado due to state legalization of marijuana products. Almost all charging devices for cell phones, iPads, etc. today use switching power supplies that radiate RF interference. WiFi routers broadcast spurious signals into the high HF bands. What it comes down to is few products actually filter radiation to specified limits. Enforcement is required as a first step, which would include blocking importation of non-compliant products.

2: Where does the problem exist?

a: Spectrally

i: 500 kHz to 54 MHz is definitely a problem, with some interference into the VHF frequencies.

b: Spatially

i: Both indoors and mobile in a car are major problems.

ii: Cities are seriously impacted as I always observe when using my ham radio mobile vehicle. As one travels within a fraction of a mile of a city, broadband HF noise levels go up 20 to 40 dB. Many rural locations are also impacted by high power line noise levels, which I observed first hand nine years ago when purchasing a rural home so I could still enjoy my ham radio hobby. Having been a ham operator for 55 years, I found it difficult to select a quiet rural location for my second home. Most ham operators in urban environments are seriously affected by high HF noise levels.

iii: While it is impossible to specify distance to most HF noise, some statements can be made. An individual switching power supply may only radiate a few hundred feet. Some are worse if they conduct back into the power grid. Specific “birdies” can often be heard for a half mile. Power line noise can affect radio reception for miles.

iv: Natural propagation is an issue, but not a major issue for urban radio reception. When listening from a quiet rural location in Colorado, noise is generally at least 10 dB stronger to the south east compared to the north east. This may be due to transequatorial propagation of noise sources and lightning in the Caribbean and South America.

c: Temporally

i: Night time noise levels are higher on the lower HF bands, while not usually so on the higher HF bands, assuming there is even propagation. As to local noise sources, time-of-day may affect RFI from timed charging and lighting devices. Many lights are controlled by photocells, and “grow light” problem mentioned earlier usually cycle in 12-hour increments.

ii: Seasonally is mostly affected by lightning induced static. Seasons also affects HF propagation, but this is has always been the case. Most RFI is local in general, within a radius of one mile or less.

3. Quantitative evidence of overall increase in noise floor, etc.

a: In a quiet location, reception of radio signals weaker than 0.1 microvolt (-127 dBm) is quite common. Thus when noise floor levels are above this level, reception is definitely impacted. Many urban environments have noise levels of several microvolts (5 uV = -93 dBm) to 10s of microvolts (20 uV = -81 dBm). This makes reception of all but the strongest signals impossible. For example, when in contact with another ham operator from my mobile (vehicular) transceiver, I often have to tell the other party that I will not be able to copy (receive) him until I exit a city.

b: My personal experience of operating a ham radio station in Denver, CO over the past 45 years, let alone the past 20 years, has show the noise floor has increased 20 dB to 30 dB. Additional noise sources such as BPL (broadband over power line) DSL and particularly VDSL are causing serious reception problems. VDSL in Boulder, CO has been fraught with interference on some of the ham radio bands.

c: I would suggest contacting the American Radio Relay League (ARRL) for data on increased noise floor over the past few decades.

4. How should a noise study be performed?

a: The number one focus should be the non-compliance of many consumer products. Second, power line noise is a major problem that should be address by the public utility companies. Corona from insulators, besides making broadband noise, also wastes electricity, which impacts our utility bills.

b: Multiple entities should contribute to studying the problem: Electric companies, OEMs of electronic equipment for both industrial and consumer purposes. The ARRL might be willing to coordinate a fund raising program so the amateur radio community could participate as a partner.

c: It should be relatively simple to make noise floor measurements from a vehicle, and record data from a swept or FFT based spectrum analyzer. The difference in noise floor between urban, rural and quiet rural is dramatic.

d: How should noise be measured?

i: There are inexpensive ($1000 or less) software defined radios (SDR) that can record large swaths of spectrum for hours if not days at a time. These devices can connect to a laptop computer with a larger hard drive. Example: Perseus receiver would an example of a $1000 solution when connected to a laptop.   http://microtelecom.it/perseus/

ii: A broadband active receiving antenna would be required. There are active whips and loops available on the market. Local ham operators in the Boulder, CO area have developed an active antenna that would serve well, and have been used to locate local noise sources in Boulder. One of the other filers on this docket is an expert and published author on this subject. (Mr. Tom Thompson)

iii: Noise is best measured in dBm, which all spectrum analyzers or SDR receiver output.

iv: Directivity would be useful when locating individual offending incidental radiators. Usually this is accomplished by using a loop antenna with a figure-of-eight bi-directional null. A loop is less effective when trying to locate power line noise, since the noise propagates down the power lines and usually doesn't have a single source of radiation.

v: Height of the measuring antenna is not a significant issue for local noise sources.

e: Measurement accuracy

Any spectrum analyzer or SDR radio has accuracies of +/- 2 dB.

i: Measurements in several urban and rural locations would be desirable. Spectral measurements should certainly include 500 kHz to 30 MHz. Spatially specific noise sources are usually a problem within a half mile of the radiator. Many broadband noise sources cannot be isolated. Temporal factors will vary with time of day. On the lower HF bands, there will be much more noise propagating in at night that may mask local noise. On the higher HF bands at night, there is generally less distant noise propagating to a receive sight, particularly with the low sun spots in the current solar cycle.

ii: There is no reason for the receiving equipment to be uncalibrated. From an absolute noise level standpoint, the main calibration issue will be gain of the active antenna vs. a single-frequency dipole. This kind of metrology problem is solvable.

iii: Input from multiple sources can likely show a trend, but would make absolute comparisons in dBm noise levels more difficult.

f: Radio astronomers usually operate at much higher frequencies than the medium wave (MW) and shortwave (SW) frequencies. Also cellular frequencies are in the UHF to SHF frequency range, and less likely to be affected by noise sources impeding MW and SW frequencies. Most broadcast auxiliary license holders are in the VHF and UHF spectrum.

g: It will not be difficult to demonstrate that reception in urban environments is drastically degraded compared to rural environments. This could be easily demonstrated with a mobile van with the appropriate equipment with a few days of measurements. I can demonstrate it on a few amateur radio bands within a few hours!

h: How can noise be distinguished from signals?

i: A spectral plot from an analyzer or SDR receiver clearly differentiates the difference. Broadband noise is more or less flat over a give frequency range. Of course specific frequencies of interference are “signals”, and show up just like a legitimate signal. Spurious emissions from a switching power supply will usually drift around in frequency, where most licensed signals are extremely stable as to frequency.

ii: As to absolute level, this depends on the reception bandwidth. Receiver noise floors for amateur radio equipment is usually quoted in a 500-Hz bandwidth. A typical ham radio receiver will have a noise floor of -135 dBm, or lower, in a 500-Hz bandwidth. A spectrum analyzer is not as sensitive as an HF receiver without a preamp. Of course a 20-dB preamp can be attached ahead of a spectrum analyzer. It would be rare in an urban environment to have a noise floor lower than -100 to -107 dBm. Many urban environments will have a noise floor as high as -70 dBm, or worse!

Sincerely yours,

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